

Technical Assistance for Vanilla

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Colombia Alternative Development Project



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Chemonics International Inc. Colombia Alternative Development (CAD) Project

Assignment: The assignment was to import in vitro produced vanilla plants into Colombia, and provide technical assistance for establishing a test plot for vanilla at the Centro Internacional de Agricultura Tropical (CIAT).

Tasks: The consultant was required to carry out two tasks while in Colombia:

- 1) Import into Colombia a total of 200 vanilla seedlings to be used to establish a test plot for vanilla at the facilities of CIAT in Cali, Colombia;
- 2) Provide guidance to CIAT technical staff in the nursery management of tissue cultured vanilla plantlets, the establishment of field trials, including: site selection; spacing of tutors (support trees); and cultural practices for the management of vanilla plantations.

Deliverables: (a) A total of 200 live vanilla plants.
(b) A report on the consultant's recommendations for the care and maintenance of the vanilla plants, the support plants, and for vanilla plant propagation.

Contacts: While at CIAT the consultant worked closely with Bernardo Ospina and Roberto Segovia. Mr. Ospina was in charge of the overall activity and Mr. Segovia was in charge of nursery and field activities. The consultant also met with Dr. Aart Van Schoohoven, Commercial Director of CIAT; Guillermo Galvez, CIAT's Haiti Project Manager; Paulina Pineda, Director of CIAT's tissue culture production lab and Carlos Huertas, ICA Phytosanitary Inspector.

Vanilla Plantlets

A total of 200 in vitro tissue cultured vanilla plantlets of a commercial variety referred to as Sarapiquí 1 were imported into Colombia and delivered to Bernardo Ospina at CIAT, Cali, Colombia (See Image 1). Sarapiquí 1 is a field selection made in Costa Rica from an F₁ backcross originally developed in Madagascar. The original hybrid was a across between *Vanilla planifolia* (the commercial species) and *Vanilla pompona* (a wild species) with the resulting hybrid backcrossed to *V. planifolia* to restore the quality characteristics of the commercial variety. This material underwent further selection while in vitro for material demonstrating hybrid vigor (See Image 2 of Sarapiquí 1 in the field).

Consultant's Report

Care and Maintenance Recommendations

Nursery Management: Vanilla plantlets require a hardening off process immediately after being removed from their in vitro environment. This consists of washing off all agar residues with water and placing them in a high humidity and nearly sterile environment during five days. This environment can be created by placing a 2 cm layer of washed gravel in the bottom of a plastic container with drain holes and covering with clear plastic. Clear plastic covers with elastic bands used for covering food containers are the most practical and are available in most supermarkets. The vanilla plantlets are placed on top of the moist gravel in an upright position and receive one application of systemic fungicide and foliar nutrients.

During the first two days of hardening off the containers are left covered but receive daily misting with chlorine free water. During days 3 and 4 the containers are left uncovered at night to lower humidity and begin stressing the vanilla plantlets. From the fifth day on the plantlets are left uncovered but continue to receive daily misting. The 200 plantlets were hardened off and received one application of fungicide and foliar nutrients. It is recommended that once removed from the Styrofoam packing box the plantlets receive an additional five days of hardening off prior to transplanting to the nursery. During this additional hardening off period the plants should be left uncovered at night and misted daily with chlorine free water.

Following the hardening off process, vanilla plantlets should be transferred to a planting material consisting of one part each of sand, dry ground coconut husk, charcoal, and a half part leaf mulch. Grass clippings make inferior leaf mulch and may lead to anaerobic conditions. Instead dry leaves from almost any broadleaf species of tree are best. In Costa Rica we use cocoa leaves with as little soil residue as possible. Black plastic nursery bags measuring 5 x 6 inches (5" high) should be utilized. For this first trial CIAT chose to use more expensive plastic pots instead of plastic bags because they were available.

The plantlets should be planted just deep enough so as not to fall over but still covering the first node and any exposed basal roots with planting material. A bamboo stake measuring approximately 1 cm by 75 cms should be put in each bag and the plantlet loosely tied to it with a cotton string (See Images 3 and 4).

The plantlets should be put under 50 to 60 percent shade and misted daily. The plantlets should then receive an application of fungicide and one week later an application of foliar nutrients. Alternating applications of fungicide and foliar spray should be made every two weeks until the plants are ready for the field. It is recommended to utilize 0.5 ml of Phyton-27 fungicide and 1.0 ml of Fosnutren foliar fertilizer per liter of water. The plantlets should be allowed to grow in the nursery until they reach the top of the support stake, which should take approximately three months.

Cultural Practices

Support Plants or Tutors: A planting density of 1,000 tutors per hectare is recommended and with a 3 x 3 meter spacing. This allows ample space for permanent shade trees. The number of shade trees varies anywhere from 30 to 100 trees per hectare depending on the species of trees and their maturity.

In Costa Rica, a nearly spineless variety of white poro (*Eritrina glauca*) has proved to be the best tutor (See Image 5). White poro has a relatively thick leaf and makes good leaf mulch. A spiny species of poro (*Eritrina spp.*) was originally used as tutors in Costa Rica, however, workers constantly complained about the spines and the biting ants that readily nested in this species (See Image 6). In most vanilla growing areas of the world, *Gliricidium sepium* is the preferred tutor, but in Costa Rica almost no one uses it since it provides only limited shade and grows poorly in high rainfall areas.

At CIAT several trees of a spiny variety of white poro were identified that could be used as planting material for tutors. A source of the spineless variety of poro should be located in the proposed project area for use as tutors. In the meantime, the spiny variety of poro located at CIAT should be used for tutors to plant the initial vanilla demonstration plots.

One meter long tutor posts should be cut from branches that are at least 5 cms thick. Posts over 10 cms thick can be used and will readily root and sprout new branches. The thicker the post the faster the tutor will sprout numerous thick branches. The live posts should only be cut during the 3 to 13 day period following the full moon to insure proper rooting. A 20 centimeter deep hole should then be dug and the tutor placed within it. Soil should then be loosely packed around the tutor so that it doesn't subsequently fall over. The above ground tip of each tutor can be painted or dipped in latex paint to protect it from termites. Once the tutor branches out avoid pruning it for at least two years since this will drastically inhibit further growth.

After the first year in the field, each vanilla plant should be provided with additional support. This can be accomplished by planting a second tutor next to the first. This second tutor should be planted within the vanilla row approximately 50 cms away on the eastern side of the first tutor. In the tropics it frequently rains in the afternoon and vanilla receives less sunlight from the western exposure. By placing a second tutor on the eastern side of the first tutor the vanilla plant receives additional shade from the morning sun (See Image 5).

Permanent Shade: The most important production parameter for vanilla is shade. Somewhere between 50 and 60 percent shade is optimal. Permanent shade should be provided by tree species with an over story higher than the tutors on which the vanilla is grown. Although the use of native species of shade trees is preferable, in Costa Rica, *Acacia mangium* (native to Southeast Asia) provides the best shade. *A. mangium* produces superior quality leaf mulch and grows very rapidly. CIAT has *A. mangium*

planted on its grounds and could be a source of seed if this species is utilized for permanent shade. Depending upon the tree species used and their maturity, between 30 to 100 trees per hectare are required to produce adequate over story shade for vanilla.

Mulching: In the rainforest, vanilla sends its roots down the trunk of the tree it is growing on and across the surface of the soil in search of organic matter. The organic matter mostly consists of fallen tree leaves from broadleaf species. Vanilla roots seldom penetrate the soil beyond the top organic layer. When transplanting to the field, the vanilla plant's roots should be planted horizontally in a shallow trench next to the tutor with the stem in a vertical position.

Soon after plants have been established in the field and tied to their respective tutors, a layer of coconut husk should be applied around each plant in a diameter of 1 to 1.5 meters. The coconut husk raises the vanilla roots off of the ground and retains moisture during the dry season. Less husk material can be used during the first year of growth, but should be increased as the plants send out increasingly more roots. The coconut husks should be placed with their interiors facing toward the soil. A layer of leaf mulch no more than 10 cm thick should then be applied on top of the coconut husk (See Image 5). Excessive mulching should be avoided so as not to produce anaerobic conditions as it decomposes. The coconut husk should last one to two years before completely decomposing. The leaf mulch should be applied at least twice a year, depending on availability and rate of decomposition. This can be accomplished by raking fallen, dry leaves from the forest floor directly onto the base of each vanilla plant or by importing dry leaves from other areas of the farm.

Weed Control: The layer of mulch around each vanilla plant should be maintained free of weeds by hand weeding. Weed control between rows can be carried out utilizing a machete or mechanical devices such as Weedeaters. The latter is preferred since it is faster and workers spend less time in the plantation damaging the vanilla's superficial root system. Herbicides are not recommended to control weeds due to pesticide drift and the sensitivity of vanilla roots. Any grass clippings that result from the between row weeding can be applied as mulch to the vanilla but only after they have completely dried.

Training: Vanilla will rapidly grow to the tips of the tutor branches making its management more difficult. In order to keep it within reach of workers, the growing tips of the vanilla vines must be detached from the branches of the tutors and trained back down to the surface of the mulch. The tip of each vine should be trained to climb once again up one of the double tutors. In this way, a curtain of vines is created and flowers are produced close enough to the ground for pollination. If the tips of vines are not placed near the base of a tutor they will rapidly grow across the ground and will subsequently be damaged during weeding.

In the tropics the moon has a significant effect on plant growth. During most of the lunar month plants tend to absorb increased amounts of water and increase their growth rate. During this period stems become brittle due to increased amounts of absorbed water. Between 3 and 13 days following the full moon plants absorb less water and decrease

their growth rate. Vanilla vines should only be trained during this period of reduced growth or otherwise instead of bending the vines tend to break off.

Disease Control: In Costa Rica vanilla is primarily affected by two fungal diseases; *Fusarium oxysporum* root rot and *Fusarium moniliforme* stem rot. Occasionally a species of *Phytophthora* may also occur but to date it hasn't been a significant problem. During dry years the incidence of root rot increases and during wet years stem rot becomes more prevalent. *F. moniliforme* stem rot can be controlled with systemic fungicides.

Of the two diseases, *F. oxysporum* root rot is the more difficult disease to control. A severe outbreak of root rot can eliminate a plantation in less than a year. Fungicide applications to control root rot have proved ineffectual and may actually interfere with the mycorrhizal fungi associated with the vanilla root system. Control measures for root rot consist of avoiding stress to the plant by providing adequate shade and leaf mulch, avoiding over-pollination of flowers (maximum 6-8 flowers per raceme); and the use of a disease resistant variety. In Costa Rica, the Sarapiquí 1 variety has proved to be resistant to vanilla root rot and more tolerant to stem rot than other vanilla varieties.

Flowering and Hand Pollination: As mentioned above, vanilla requires a distinct dry season in order to flower. The reduced moisture and increased solar insulation associated with the dry season stresses the plant and induces flowering. In Costa Rica flowering begins in March and is essentially over by the end of May.

During the flowering season, workers pollinate all the open flowers they can find each morning prior to 12:00 noon. After midday, the flowers are no longer viable and are very difficult to pollinate. The following day the vanilla plant will open new flowers for pollination. Pollinated flowers from the previous day will be shriveled up but will still be attached to the immature vanilla beans. If a flower subsequently detaches from the immature bean within a day or two following pollination it wasn't successfully pollinated. This isn't a major problem however since each raceme will produce up to twenty flowers for pollination.

To insure large beans and avoid stressing the plant with too large a crop, only 6 to 8 flowers on each raceme should be pollinated. The smaller flowers that open later in the flowering season should be left unpollinated. A mature vanilla plant will produce numerous racemes during the flowering season.

Establishment of Field Trials

Growing Conditions: There are 110 species of *Vanilla* distributed in both the Old and New World, but only *V. planifolia* (syn. *V. fragrans*), *V. tahitensis* (Tahitian vanilla) and *V. pompona* are economically important with the latter two yielding inferior quality beans. *V. planifolia* is an orchid indigenous to the lowland tropical regions of south-eastern Mexico, Guatemala and Central America. In the rainforest, vanilla grows up mature trees to heights of over thirty meters. Vanilla therefore grows best in areas with conditions

similar to the lowland rainforest environment, i.e. at elevations of between 0 to 600 meters above sea level, 2,000 to 2,500 mm of annual rainfall and a 2-month dry period. In vanilla growing areas these exact, ideal conditions are seldom encountered.

Site Selection: CIAT receives approximately 1,200 mm of rainfall annually which is well below the 2,000 mm minimum required by vanilla. Although CIAT is also located at an elevation of over 1,000 meters (exceeding the 600 meter limit), it is the consultant's opinion that vanilla can be produced at nearly any elevation as long as its moisture and light requirements are met. CIAT has three potential sites for establishing vanilla trials: an area planted in plantains, a *Leucaena spp.* trial and a 2-hectare forest situated next to an artificial lake. All three sites could be made suitable for demonstration plots; however irrigation would be required at each site during the dry period. The forested site has conditions most suited for vanilla production.

It is recommended that CIAT establish a demonstration plot(s) in lieu of variety trials. As stated above, the forested area provides conditions most similar to vanilla growing areas and would be the best location for establishing a demonstration plantation. The site would require some reduction of shade and the installation of a reliable sprinkler irrigation system. A gravity feed system would not provide the overhead irrigation necessary to maintain moisture in the layer of leaf mulch and could lead to flooding and anaerobic conditions in the root zone of the vanilla. A demonstration plot could be established at the site with *Leucaena* after an extensive reduction of shade. Vanilla could also be planted on the site with plantains but only after planting permanent shade trees.

Costa Rican Growing Conditions: In Costa Rica vanilla has been successfully produced at elevations below 600 meters, with an annual rainfall regime of between 3,000 and 8,500 mm and an 8 to 12-week dry period. The major vanilla producing area of Costa Rica is located in the vicinity of Quepos, a small port town on the Pacific coast. In 1996 nearly all the vanilla plantations in the area were destroyed by *F. oxysporum* root rot. The only plantations that survived were small farmer plots of less than a hectare. Larger plantations were totally destroyed and subsequent replantings with the local unimproved and probably contaminated variety eventually succumbed to the disease. The root rot disease was eventually controlled by planting clean seed of a disease resistant variety obtained from Madagascar. The planting material was reproduced using in vitro tissue culture methods. The Sarapiquí 1 variety is a further selection of this original disease resistant material.

Since 1995, a vanilla grower in the Quepos area located at an elevation of 200 meters above sea level has been collecting rainfall data. During the last seven years annual rainfall has ranged from a low of 6,000 mm to a high of 8,500 mm with an average of 6,500 mm (See Figure 1). The 8,500 mm high in year 2000 corresponds to the effects of hurricane Cesar. Average monthly rainfall for Quepos is presented in Figure 2. Note the three-month dry season starting in January which exceeds the ideal two-month period required by vanilla to induce flowering. This extended dry period probably contributed to the increased incidence of *F. oxysporum* root rot and the precipitous decline of the vanilla sector starting in 1996. Although growing conditions in Quepos greatly exceed

what is considered ideal, vanilla is now being successfully produced there mainly because of the use of a disease resistant variety.

In the Atlantic region of Costa Rica the Organization for Tropical Studies (OTS) maintains the La Selva Biological Field Station near Puerto Viejo de Sarapiquí. La Selva is located five kilometers south of the consultant's vanilla plantation. Since 1957 OTS has collected rainfall data which is presented in Figure 3. Over the last 45 years annual average rainfall has ranged from a low of 3,000 mm to a high of 6,000 mm with an overall average of 4,200 mm. Figure 4 contains average monthly rainfall data for the last 45 years and the last 6 years. In contrast to Quepos, Sarapiquí has a slightly shorter dry period and may be the reason why *F. oxysporum* root rot has so far not become a significant problem.

Putumayo as a Vanilla Producing Area: From a cursory review of rainfall data for Putumayo it would appear that growing conditions are similar to the Sarapiquí region of Costa Rica implying that vanilla would probably do well there. Also, Putumayo appears to have a sufficiently long dry season to induce flowering although it is out of phase from Costa Rica by a couple of months. This means Colombia should have flowering and production earlier in the season than Costa Rica. A closer examination of rainfall data for the area should be made to insure the growing conditions are suitable for vanilla.

Vanilla can be grown in areas without rainforest. In Costa Rica, cocoa plantations make ideal sites for vanilla production since cocoa requires permanent shade and drops its leaves at least twice a year. The additional shade provided by cocoa must be reduced by pruning to insure the proper growth of the poro tutors and of course the vanilla. Coffee plantations of the old Arabica variety (shade coffee) should also provide suitable conditions of light and leaf mulch for vanilla. However, the rainfall regime of the coffee site must also be within the parameters for vanilla.

Vanilla Plant Propagation

Propagation by Cuttings: A one meter vanilla cutting from a mature healthy plant will produce flowers approximately two years after planting and beans nine months later. The use of cuttings can save up to one year of time to reach production compared to in vitro tissue production methods. This depends of course on what time of year the cuttings are planted and the condition of the cuttings. However, experience has shown that this method is very dependent upon having access to a mature plantation whose owner is willing to sell cuttings. The cuttings should be from a disease resistant variety and be certified free of viral, bacterial and fungal diseases. Given the currently high prices of vanilla on the world market it may prove difficult to obtain cuttings. In Costa Rica nearly all the initial plantings of vanilla were made with cuttings. After the outbreak of *F. oxysporum* root rot, commercial growers almost exclusively replant with tissue cultured plantlets.

CIAT's Tissue Culture Laboratory: CIAT has a tissue culture laboratory with sufficient unused capacity to produce large quantities of vanilla plantlets. The laboratory director,

Paulina Pineda has extensive experience with in vitro production of various crops and could easily produce vanilla plantlets. With some outside technical assistance CIAT could produce sufficient vanilla plants to establish a vanilla industry in Colombia.

Appendices



Image 1



Image 2



Image 3



Image 4



Image 5



Image 6

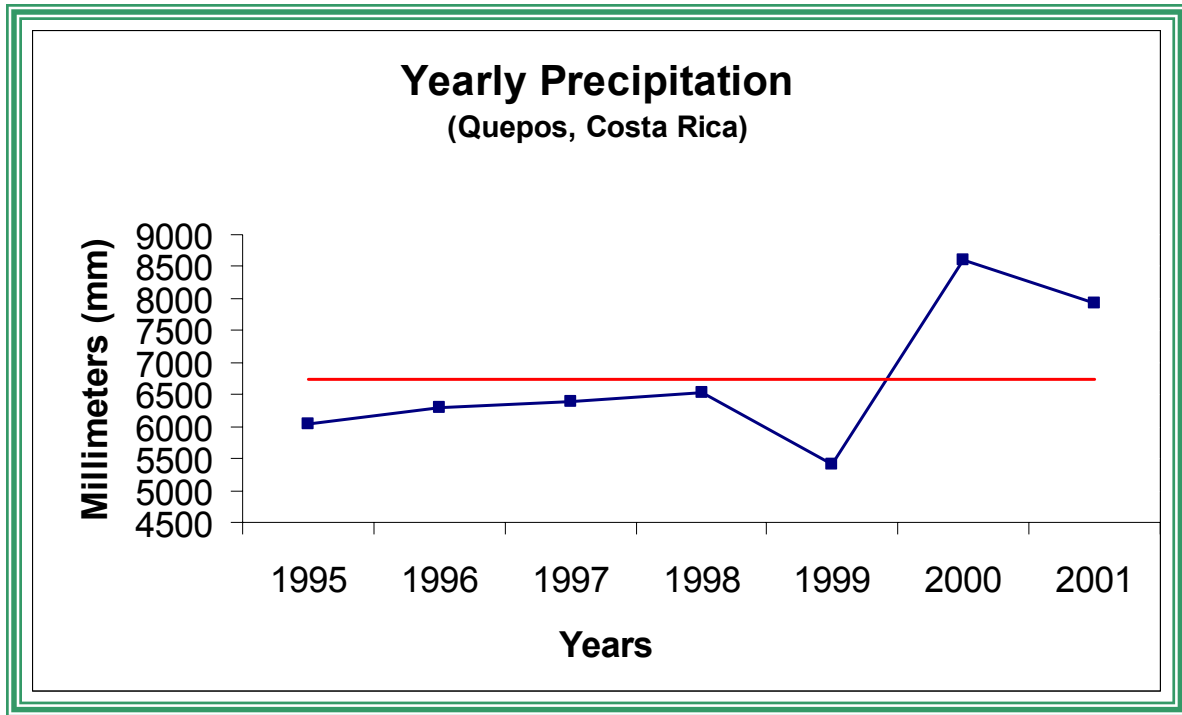


Figure 1

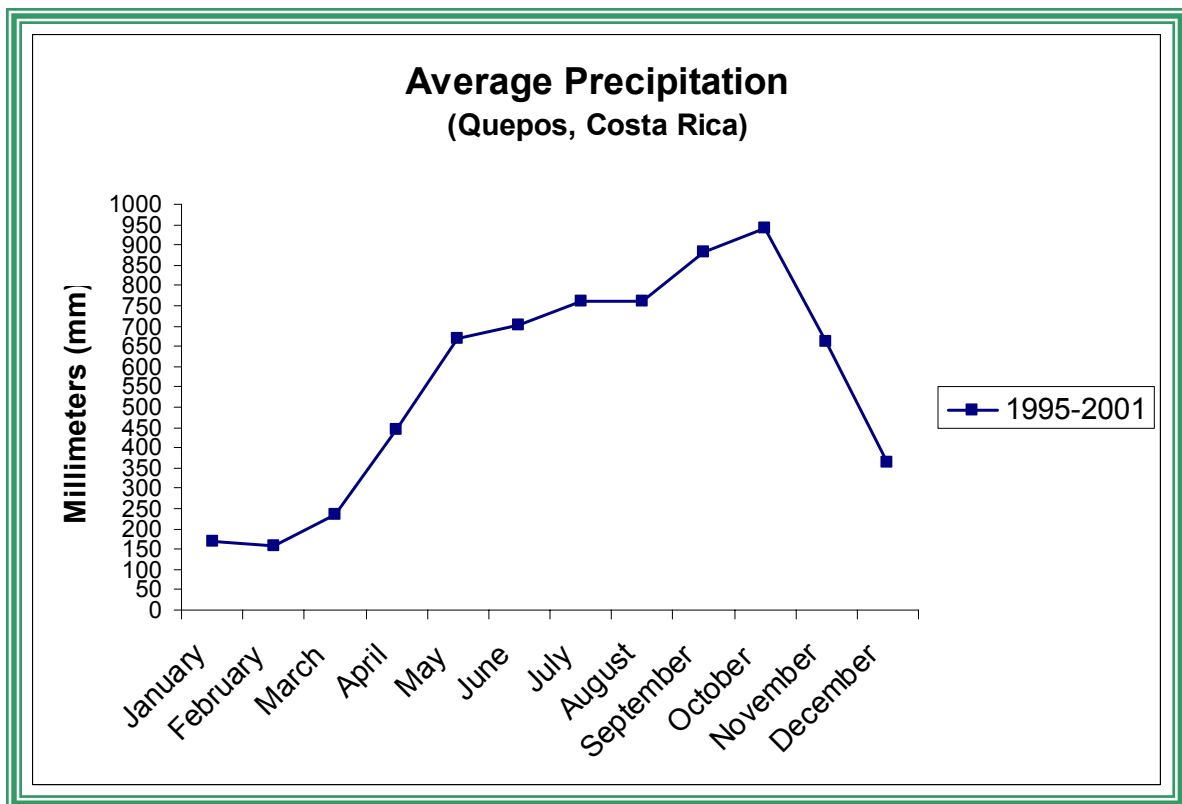


Figure 2

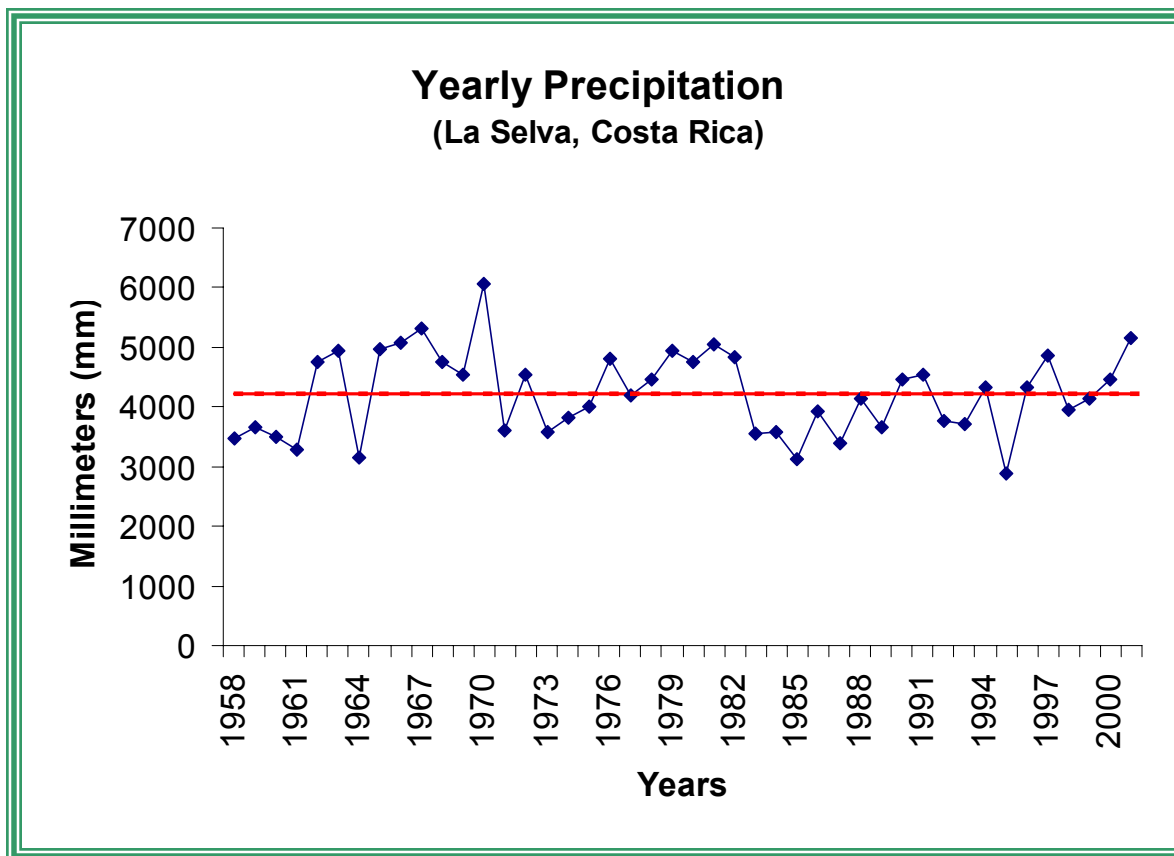


Figure 3

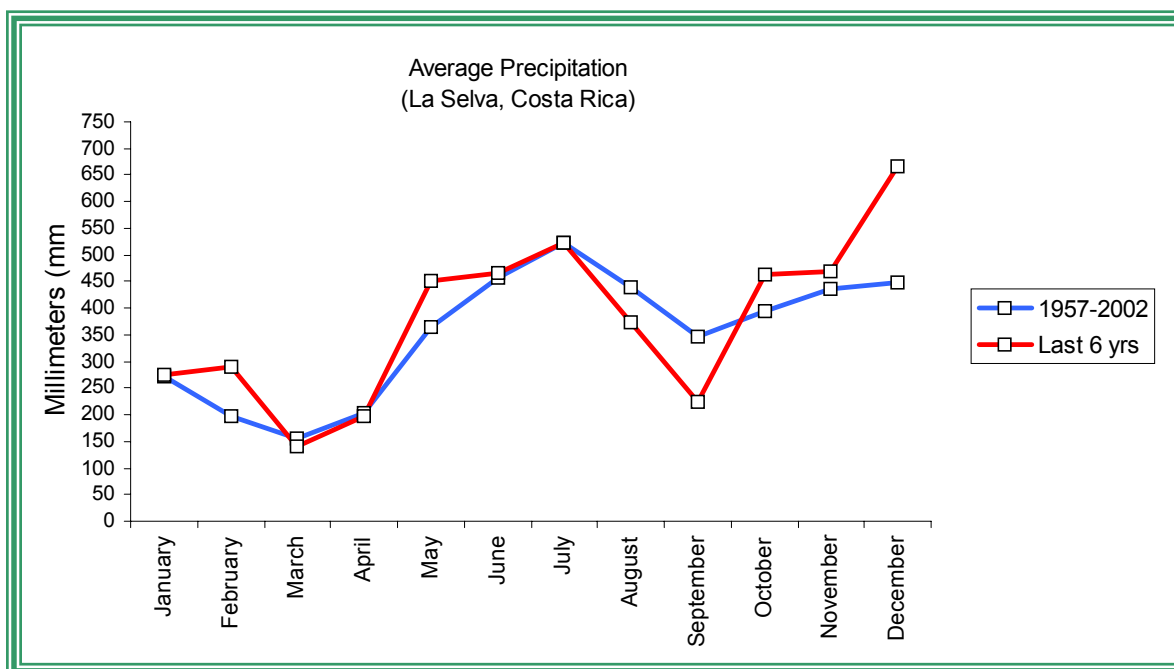


Figure 4